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A maintenance policy for a partially observable parallel system with two components subjected to stochastically dependent degradation processes} **A maintenance policy for a partially observable parallel system with two components subjected to stochastically dependent degradation processes**

Degradation modelling based on stochastic processes has become a key tool in reliability analysis and condition-based maintenance of engineering systems. While a large body of literature addresses single-component systems, many practical assets consist of multiple components whose degradation processes are influenced by common environmental or operational factors. In such systems, component deterioration is often correlated, and maintenance decisions become particularly challenging when only partial information on the system state is available. This situation arises when some components can be directly inspected while others remain hidden or inaccessible, requiring maintenance policies that account for both dependence among components and incomplete state observability.

This paper investigates maintenance decision-making for a parallel two-component system in which one component is fully observable and the other is latent. The degradation of both components is modelled through stochastic degradation processes driven by a shared random effect, capturing the influence of unobserved environmental or operational conditions and inducing correlation between the two degradation trajectories. At inspection times, the degradation level of the observable component is perfectly known, whereas the state of the latent component must be inferred indirectly from the information provided by the observable one.

The system is assumed to operate over a finite time horizon with a single inspection and maintenance opportunity. At the inspection time, the decision-maker observes the degradation state of the accessible component and selects an optimal maintenance action. System failure is defined through a threshold-based degradation model, linking component deterioration to system lifetime. The objective is to determine the optimal inspection timing and the corresponding maintenance action that minimise the expected cost per unit of time over the system lifetime.

The analysis focuses on a one-inspection policy in order to clearly isolate and characterise the informational contribution of the observable component to the maintenance decision process. This modelling choice allows the role of correlation and partial observability in supporting optimal decisions to be examined in a transparent way. Nevertheless, restricting the number of inspection can also provide operational and/or economic benefits in some industrial applications (such as, for example, offshore energy or large-scale plants) where the mobilisation of specialised inspection teams and the downtime associated with maintenance interventions may justify policies with limited inspection opportunities.

Obtained results offer insights into the value of indirect information in condition-based maintenance policies.

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